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Global Chaos Control of the FitzHugh-Nagumo Chaotic Neuron Model via Integral Sliding Mode Control

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Abstract: Chaos is an important applied area in nonlinear dynamical systems and it is applicable to many real-world systems including the biological systems. Nerve membranes are known to exhibit their own nonlinear dynamics which generate and propagate action potentials. Such nonlinear dynamics in nerve membranes can produce chaos in neurons and related bifurcations. In 1952, A.L. Hodgkin and A.F. Huxley proposed a nonlinear dynamical system as a mathematical model of nerve membranes based on their electrophysiological experiments with squid giant atoms. Chaos in nerve membranes have been studied in the chaos literature both theoretically and experimentally. In this paper, we investigate the qualitative properties of the well-known FitzHugh-Nagumo (FHN) chaotic neuron model, which is a two-dimensional simplification of the Hodgkin-Huxley model of spike generation in squid giant axons. Next, new results are obtained for the output regulation of the FitzHugh-Nagumo (FHN) neuron model via integral sliding mode control (ISMC) method. MATLAB plots have been shown to illustrate the phase portraits of the FitzHugh-Nagumo (FHN) neuron model and the output regulation of the FHN neuron model.

Keywords: Chaos, chaotic systems, output regulation, biology, biological system, neuron, sliding mode control, FitzHugh-Nagumo system, bifurcations, nerve membranes, etc.

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